
Space Weather Technical Forecast

Issued on Monday, 06 February 2023 at 00:38 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales <https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales>

Space Weather Forecast Headline: Chance of G1/Minor Storm intervals. Probable increase in X-ray flare activity.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Low over the past 24 hours, with X-ray activity recorded at GOES16 generally subdued near the B/C flux boundary but with isolated mid-ranking C-class flares observed. These peaked with a C6.6, near the southeast limb at 05/0326UTC and a C6.4 from AR3211 in the southwest quadrant at 05/1050UTC.

There are now up to six sunspot regions on the solar disc, with AR3210 having faded to plage in the southwest as a new faint unnumbered region developed nearer the meridian, also joined by a new unnumbered arrival in the far northeast. There were four surviving numbered regions, however these generally took the form of small and magnetically simple groups, with AR3211 perhaps the most notable spot as a slowly proliferating and spreading Cro/Beta.

Up to three prominence eruptions were observed from the southeastern limb in the period: the first visible as a dimming in AIA211 at 05/0300UTC; while the remaining two were visible in both EUV and Cerro Tololo H-Alpha imagery. These comprised an impulsive eruption at 05/1400TC; and secondly a slower release starting 05/2000UTC. None of these events should affect Earth, and no solar radiation enhancements were seen.

Of potentially greater note was a dimming associated with the C6.4 flare from AR3211 at 05/1050UTC, with an apparent faint Coronal Mass Ejection (CME) subsequently visible on coronagraph imagery. This feature has been analysed and determined to most likely pass 1AU ahead of and below the track of the Earth in its orbit. Yet another dimming was seen from a small C-class flare from AR3209 at 05/1939UTC, however no subsequent ejecta was identifiable in imagery. No Earth-directed CMEs therefore feature in the forecast at present.

Solar Wind / Geomagnetic Activity: Solar wind parameters, as observed by DSCOVR and ACE at L1, were indicative of slow wind regime. The solar wind speed was a Background levels throughout, with an initial slight decrease and then level tendency near 350km/s. The solar wind density showed a gradual rise over the same interval, passing through single figures ppcc to end near 15ppcc. The IMF showed a gradual increase from Background to Slightly Elevated levels in rising from near 5nT to reach 11nT by the period's end. The north-south component showed an erratic tendency, with a gradually increasing amplitude to peak between +8 and -9nT. Finally, the phi angle was mostly negative (towards the Sun), with a change to positive seen after 05/2300UTC.

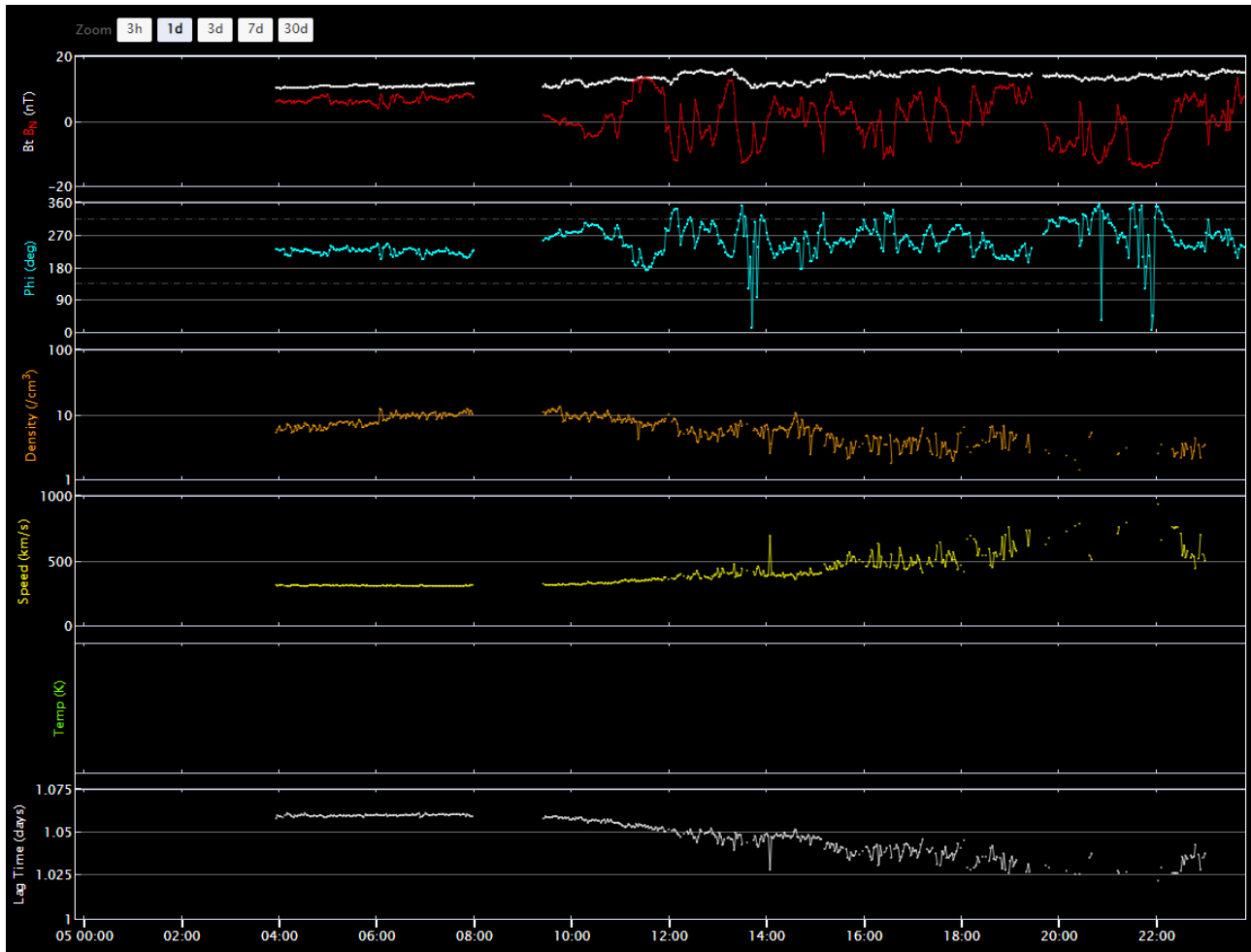


Figure 0: STEREO A MAG and PLASTIC measurements for the past 24 hours, indicating a high speed stream from around 05/1100UTC at the satellite. Given that STEREO A is sampling around a day upwind in the Parker spiral at present, CH74/- is due with reasonable confidence around the middle of the current UTC day at Earth, with some signs that the preceding minor CIR is already occurring here.

The net result of the above solar wind measures was for Quiet geomagnetic activity, with a provisional peak Kp of '2o' seen in the 03-06UTC interval.

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) as measured at GOES16 remained at Background levels throughout.

The high energy electron flux (greater than 2MeV) measured by GOES16 was predominantly at Normal Background levels. The associated 24-hour electron fluence was below the Active threshold on a declining trend. The observed fluence at 06/0001 UTC was 1.36e6 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Low solar activity is likely during the forecast period. There are signs that the arriving eastern limb contains more potent active regions (from CME evidence, prominences and STEREO A EUVI 195 imagery), with a probable increase in activity therefore considered through the coming UTC working week, and thus an increasing Chance of M-class flares.

Solar Wind / Geomagnetic Activity: No definitively Earth-directed CMEs feature in the forecast at present, however given the sheer number of peripheral CMEs over the UTC weekend, confidence Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

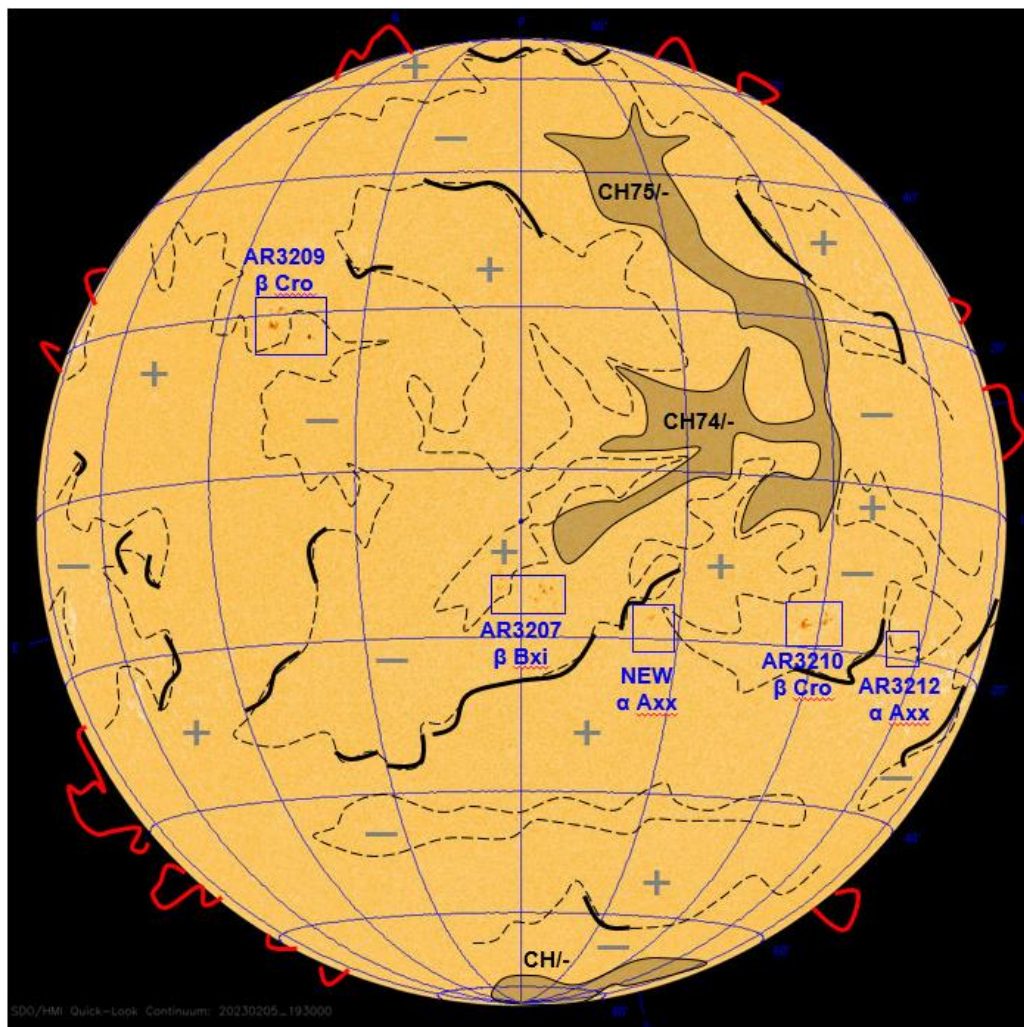
in this assertion is relatively low, especially from Day two, Tuesday 07 February. Non-impactful glancing transient activity is considered a possibility through the middle of the coming week.

The current slow regime is expected to give way to the fast wind from CH74/- around the middle of Day one, Monday 06 February to give a Chance of Minor Geomagnetic Storm G1. A residual Slight Chance of G1 should then continue into Day two, before a probable reduction to Quiet from midweek.

Energetic Particles / Solar Radiation: The high energy (greater than 10 MeV) proton flux observed by GOES16 is expected to remain at Background levels throughout given the dearth of current sunspot groups.

Background electron flux is likely to increase to Moderate or perhaps High levels from midweek (UTC), due to the fast wind environment, although the corresponding electron fluence is unlikely to exceed the Active ($1e8$ integrated pfu) threshold in the forecast timeframe.

Figure 1. Solar Analysis Valid 05/1930UTC.



Key: Filament — , Prominence — , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α - β - γ - δ and Zurich-McIntosh Axx etc.

Geomagnetic Storms:

There are no definitively Earth-directed CMEs currently in the forecast. This being said, observed minor peripheral CMEs comfortably reached double figures over the past UTC weekend, and confidence in this assertion is therefore lower than typical. It is probable that non-impactful minor glancing CME incidence may occur later this working week, and attribution to any one event is likely to be very difficult.

This is reflected in some of the MOSWOC Enlil ensemble members showing minor deviations from the unperturbed deterministic run on or after the second half of Tuesday 07 February, i.e. Day two. This is felt to lie on the early end of any possible influence given Enlil's erroneous assumption that Earth has been transiting a 600-650km/s fast wind over the UTC weekend, when in fact a slow regime near 300-350km/s has instead prevailed. Any glancing CME would therefore most likely be delayed until on or after midweek UTC.

With the above uncertainties mainly affecting the second half of the coming UTC working week, a fast wind from CH74/- should characterise the start. There are now strong signals that this is incipient at STEREO A, and arrival at L1 and Earth is highly likely around the middle of the current UTC day. The weak leading CIR already appears to be ramping up, with a gradual rise in density seen at ACE and DSCOVR at present, as well as a gradual opening out of the IMF. There is a peak Chance of Minor Storm G1 on arrival of this feature, which is much-enlarged relative to last pass, and may also be more impactful for being negative polarity on approach to the spring equinox.

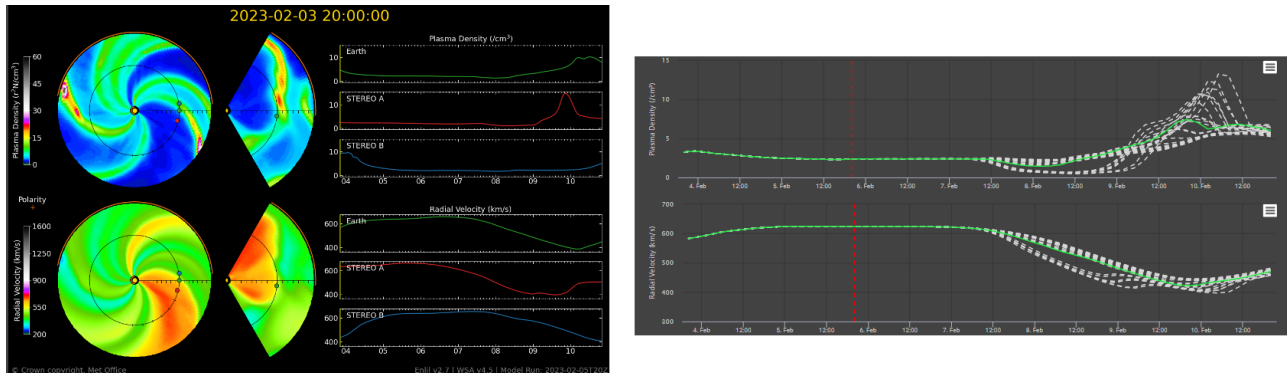
All considered, Quiet geomagnetic conditions will Likely give way to Active with a Chance of a Minor Storm G1 later on Day one, carrying over as a Slight Chance into Day two. The forecast from midweek UTC has inherent high uncertainty given passing transients, but should most likely see a reduction to Quiet as the fast wind gradually wanes into the second half of the week.

Geo-Magnetic Storm	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Minor or Moderate	G1 to G2	No	30	20	5	5
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Nil, but low confidence – especially from midweek UTC

Figure 2: Latest MOSWOC Enlil run (05/2000UTC) and ensemble, showing a proliferation of solutions beyond the second half of the UTC day of Tuesday 07 February, the result of close passes by several CMEs emitted over the UTC weekend. These do not constitute the favoured evolution but serve to illustrate that minor disturbances are possible later this coming working week. Note that MOSWOC Enlil is currently showing an erroneously fast high speed stream as being felt at Earth at present, and its absence is likely to delay any minor transient effects shown in the ensemble.



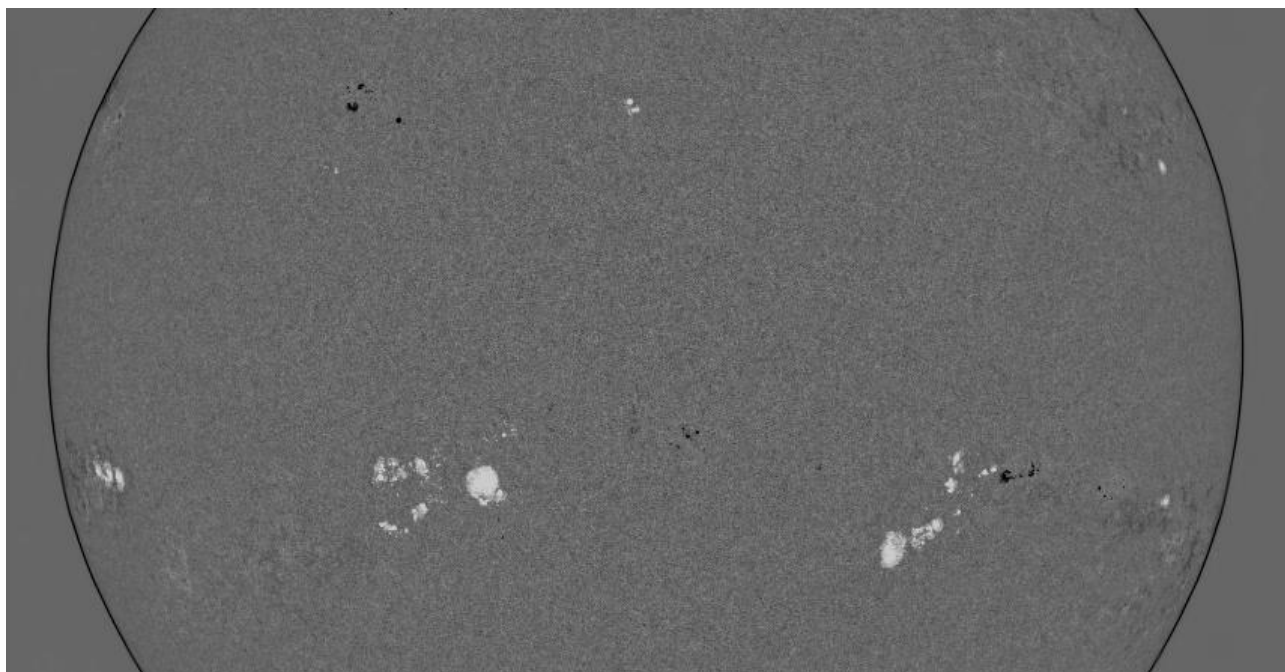
Radio Blackouts - X-Ray Flares:

The current solar disc consists of relatively few and simple bipolar sunspot groups, with Low solar activity observed.

There is the potential for the arrival of numerous Carrington locations for spot groups over the eastern limb in the first half of the coming UTC working week. In numerical order Ex-AR3288; 3290; 3291; 3292; 3294 and 3295 are all due over the coming days. Therefore there is an increasing chance through the period of moderate solar activity and isolated M-class flares.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	10	20	30	30
Very Active	R3 to R5 X Class	No	1	1	1	1

Figure 3: Helioviewer.org-generated running difference imagery comparing sunspot group footprints from 27 days ago (white) to the current disc (black), showing a recent lull in the otherwise upward trend in activity towards solar maximum.



Solar Radiation Storms - (High Energy Protons):

High energy (greater than 10MeV) proton flux as observed by GOES16 is at Background levels, and is currently expected to remain as such throughout the period given the absence of significant sunspot groups.

Radiation Storms	Level ($\text{cm}^{-2} \text{sr}^{-1} \text{s}^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	$\geq \text{S1}$	No	1	1	1	1
Very Active	$\geq \text{S3}^*$	No	1	1	1	1
* $\text{S3} \geq 10 \text{ MeV} \geq 1000 \text{ pfu}$ and / or $\geq 50 \text{ MeV} \geq 10 \text{ pfu}$. (pfu = $\text{cm}^{-2} \text{sr}^{-1} \text{s}^{-1}$)						

High Energy Electrons Event ($\geq 2\text{MeV}$):

High energy electron flux (greater than 2MeV) as observed by GOES16 is currently at Normal Background levels, and is expected to remain so in the near-term. However, an eventual increase to Moderate and perhaps High levels is likely from midweek UTC in a response to the anticipated coronal hole fast wind environment. STEREO A is currently giving very noisy traces for solar wind speed arising from CH74/- of between 500 and 750km/s, however something nearer the bottom end of this range is considered most likely, which would perhaps give an eventual Chance of fluence exceeding Active.

MOSWOC REFM is rendered less useful for this forecast period as the solar wind enhancement is both non-persistent and potentially polluted by minor transient activity later this working week.

GEO Electron Environment	Level ($\text{cm}^{-2} \text{sr}^{-1} \text{day}^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	$\geq 2 \text{ MeV}$ $\geq 1 \times 10^8$	No	1	10	20	40
Very Active	$\geq 2 \text{ MeV}$ $\geq 1 \times 10^9$	No	1	1	1	1